FERTILISATION OF FLOWERS BY INSECTS *

VIII.

Alpine Species adapted to Cross-fertilisation by Butterflies, while the most nearly allied species which inhabit the plain or lower mountain region are adapted to Cross-fertilisation by Bees.

IN the last article I attempted to show that in the Alpine region Lepidoptera are far more frequent visitors of flowers than in the plain and lower mountain region, while the frequency of Apidæ, not only absolutely but to a still greater extent relatively, is greatly diminished towards the snow-line. If this be so, whatever may be the cause of the fact, it is hardly to be supposed that the

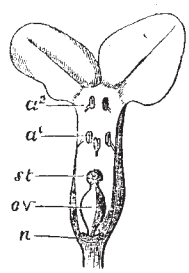

FIG. 41.—*Daphne Mezereum*, L., dissected longitudinally.

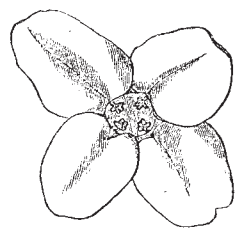

FIG. 42.—The same flower viewed from above.

(Both figures 3½ times natural size.)

different proportion of visitors of such different structure as butterflies and bees should not have in any way influenced the adaptations of the flowers; and indeed, even during my short stay in the Alps, I succeeded in finding some species of flowers adapted to cross-fertilisation by butterflies, their most nearly allied species which inhabit the plain or lower mountain region being adapted to cross-fertilisation by bees.

1. *Daphne Mezereum* and *striata*.—In both species (Figs. 41-44) the nectar is secreted in an annular swelling (*n*) at the base of the ovary (*ov*), and is contained in the lowest part of the tubular corolla, which includes (1) the ovary (*ov*), terminated by a short-styled, knobbed stigma

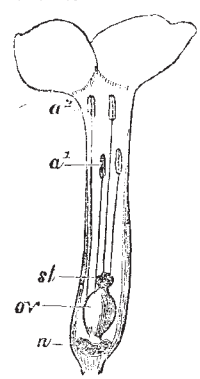

FIG. 43.—*Daphne striata*, Trat., dissected longitudinally.

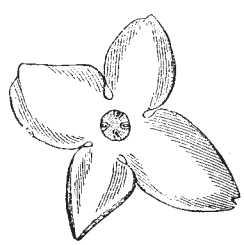

FIG. 44.—The same flower viewed from above.

(Both figures 3½ times natural size.)

(*st*); (2) four lower anthers inserted above the centre of the corolla-tube (a^1); and (3) four higher anthers inserted near its mouth (a^2). In both species, therefore, the proboscis of a visiting insect, when in search of the honey, grazes at first the higher, then the lower anthers, and at last the stigma; but the pollen-grains, being only slightly sticky, scarcely adhere to the proboscis, and, at the most, some few grains will be brought by it to the stigma of the same flower. Only when retreating out of the flower will the proboscis, wetted with honey, be dusted by any considerable number of pollen-grains, which will partly be deposited on the stigma of the next visited flower. Thus cross-fertilisation is secured in case suitable insects visit the flowers, whereas when visits of suitable insects are wanting, pollen may easily fall down in both species from the anthers upon the stigma of the same flower, and effect self-fertilisation.

Agreeing thus far, the flowers of the two species differ remarkably in the length and width of the corolla and in the insects which they attract. The corolla-tube of *Daphne Mezereum* being 6 mm. long and 2 mm. wide, its honey is accessible to a great number of bees, among them to all humble-bees, and to some flies (Eristalis, Rhingia), which will be attracted by the bright red colour, and when seeking for honey and flying from flower to flower will regularly effect cross-fertilisation. The honey is also accessible to butterflies, but in consequence of the width of

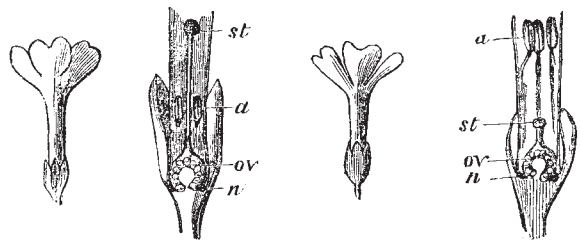

FIG. 45. FIG. 46. FIG. 47. FIG 48.

FIG. 45.—*Primula villosa*, Facq. Long-styled flower, natural size. FIG. 46.—Lower part of the same flower, longitudinally dissected; 3½ times natural size. FIG. 47.—Short-styled flower, natural size. FIG. 48.—Lower part of same flower, longitudinally dissected; 3½ times natural size. *n*, nectary; *ov*, ovary; *st*, stigma; *a*, anthers.

the corolla-tube the slender proboscis of these insects will often be entered and retracted without touching anthers and stigma. *Daphne striata*, on the contrary, with corolla-tubes of 10-11 mm. long, the entrance of which is only 1 mm. wide, is hardly accessible to any insects except Lepidoptera; and the pale rose or whitish colour of its flowers, crowded together in tens or twenties into umbels, and the entire absence (or nearly so) of scent in the day-time, while they emit a remarkably sweet scent during the evening twilight, prove them to be adapted to Sphingidæ and moths,* which, when visiting the flowers, in consequence of the narrowness of the corolla-tube, cannot avoid grazing the anthers and stigma and regularly effecting cross-fertilisation.

FIG. 49.

FIG. 50.

FIG. 49.—*Primula officinalis*, Facq. Long-styled. Natural size.

FIG. 50.—The same: Short-styled flower, longitudinally dissected.

(Copied from Hildebrand, "Geschlechtervertheilung," p. 34.)

2. *Primula officinalis* and *villosa* (Figs. 45-50) are connected with one another by a relation analogous to that between *Daphne Mezereum* and *striata*. Both offer the remarkable contrivances for cross-fertilisation which Mr. Darwin has discussed in so masterly a manner in his paper on Primula,† that is to say, both possess two forms of flowers, a long-styled (Figs. 46, 49) and a short-styled (Figs. 48, 50), growing on different stems and existing in nature in about equal number. As is evident from the

* Continued from p. 33.

* I have not yet succeeded in actually observing the fertilisation of either of these two species of Daphne.

† "On the Two Forms or Dimorphic Condition in the Species of Primula and their remarkable Sexual Relations." Proc. Linn. Soc. vi. (1862). Bot. pp. 77-99.

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comparison of Fig. 46 with 48 and of 49 with 50, the anthers of the short-styled form are placed at the same height in the corolla-tube as the stigma of the long-styled, and, conversely, the stigma of the short-styled at the same height as the anthers of the long-styled form. Hence the same part of the body (head or proboscis) of any visiting insect which has touched the anthers of the short-styled form touches the stigma of the long-styled form, and conversely, so that by the regular visits of insects, flowers of the long-styled form are fertilised by pollen of short-styled flowers, and *vice versâ*. Thus in *Primula officinalis* and *villosa*, as in all dimorphic species, intercrossing of different plants takes place naturally; and, as Mr. Darwin has proved by experiment, is the only manner of fertilisation that is followed by perfect fertility. But whilst identical in the arrangement of all the parts of the flower and in their remarkable sexual relations, our two species of Primula differ in the wideness of their corolla-tube to such an extent that the wide mouth of the flower of *P. officinalis* is capable of including the whole head of a humble-bee; whereas the narrow corolla-tube of *P. villosa* is not capable of including anything larger than the proboscis of a humble-bee (compare the corolla-tube in Figs. 46 and 48, which, although three-and-a-half times magnified

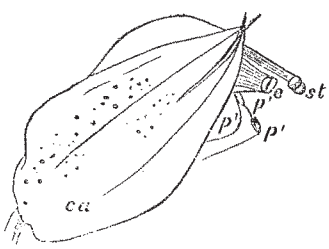

Fig 51.

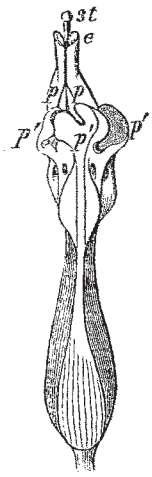

Fig. 52.

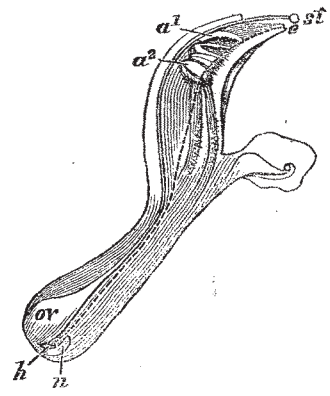

Fig. 53.

appears hardly as wide as the mouth of the flower in Figs. 49 and 50, which is the natural size). In consequence of this narrowness, the flowers of *P. villosa* are not only unavoidably cross-fertilised when visited by butterflies, but they are also far more attractive to butterflies, because their honey, inaccessible to humble-bees, is reserved for them alone; indeed, except some little Coleoptera, I observed only Lepidoptera visit the flowers of this Alpine species of Primula,* whereas the flowers of *Primula officinalis* are adapted by their dimensions to the visits of humble-bees, and are actually visited by them.*

A third example of the same relation between Alpine species and those from the lowlands is presented by *Rhinanthus alpinus* (Figs. 51-56), as compared with *R. crista galli* (Fig. 57). *R. crista galli*, which grows in the plain and lower mountain region, presents two varieties or sub-species: α, *major*, and β, *minor*, with different forms of flowers; *major* with more conspicuous

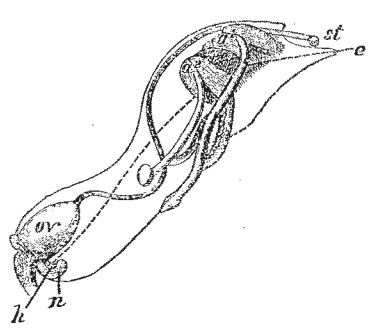

Fig. 54.

Fig. 55.

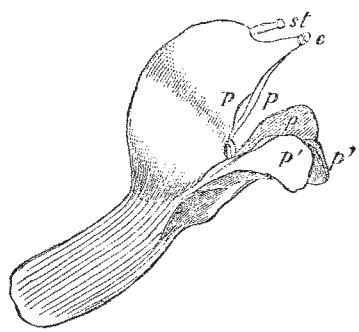

Fig. 56.

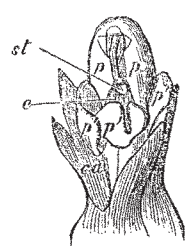

Fig. 57.

Figs. 51–56.—*Rhinanthus alpinus*.—Fig. 51.—Lateral view of a young flower when still almost entirely enclosed in the calyx (*ca*). Fig. 52.—Corolla of another young flower, somewhat more full-grown, viewed from beneath. Fig. 53.—The same corolla, longitudinally dissected. Fig. 54.—Corolla of an older flower viewed laterally. Fig. 55.—Front view of the same flower. Fig. 56.—Corolla of the same flower, longitudinally dissected, but all four anthers reserved. Fig. 57.—*Rhinanthus crista galli*, β minor.

All figures are 3½ times natural size. In all figures:—*ca*, calyx; *p p*, upper petals, forming together the upper lip; *p' p' p'*, under petals, forming the underlip; *a'*, longer stamens; *a²*, shorter stamens; *n*, nectary; *h*, honey; *ov*, ovary; *st*, stigma. The dotted line on Figs. 53 and 56 signifies the supposed path of the proboscis of butterflies.

ones which never fertilise themseves, *minor* with less conspicuous ones regularly fertilising themselves, in case the visits of insects are wanting (NATURE, vol. viii., pp. 433-435). Both are adapted to cross-fertilisation by humble-bees, which, inserting their proboscis into the comparatively wide entrance of the upper lip (*e*, Fig. 57)

* Visitors of *Primula villosa*.—(A.) Coleoptera: *Anthobium excavatum*. Er., frequently, crawling without difficulty into the flowers and out of them. (B.) Lepidoptera: *Pieris callidice* Esp., *Zygæna exulans* Rain, both sucking perseveringly and flying from flower to flower.—Piz Umbrail, July 16, 1874.

* Visitors of *Primula officinalis*.—(A.) Coleoptera: *Meligethes*. (B.) Diptera: *Bombylius discolor* Mgn., sucking. (C.) Hymenoptera, Apidæ: *Anthophora pilipes* F., ♀ ♂, *Bombus muscorum* L. ♀, both frequently sucking; *Andrena Gwynana* K. ♀, *Halictus cylindricus* F. ♀ and *Halictus albipes* F. ♀, collecting pollen of short-styled flowers.—Thuringia, April 16, 1873.

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and pressing it between the upper parts of the filaments, cannot fail to pull asunder the anthers, and thus to cause many loose pollen-grains to fall down upon the proboscis, which are deposited on the stigma of the next flower following.* Thus, in both, cross-fertilisation is secured in case humble-bees visit the flowers, whereas butterflies may easily thrust their slender proboscis down to the honey without even touching the anthers, consequently without any benefit to the plant. Suppose, therefore, that *R. crista galli* (*α*) *major* were growing in the Alpine region, and visited frequently by butterflies, but never or only very exceptionally by humble-bees, all or nearly all the individuals would of necessity perish without leaving posterity, unless any modification of the flowers adapted to cross-fertilisation by butterflies appeared. *R. alpinus* may perhaps be considered as having originated in such a way; for the arrangement and mutual situation of all the parts of its flower is just the same as in *R. major*, with only this modification, that the entrance between the margins of the upper lip (*e*, Fig. 57), through which in both forms of *R. crista galli* butterflies as well as humble-bees thrust their proboscis, in *R. alpinus* is completely closed (*pp*, Figs. 54, 55), only a minute opening (*e*, Figs. 51-56) between two lateral flaps being visible at the tip of the beaked prolongation of the upper lip. No other insects except butterflies would be able to insert their proboscis through this narrow entrance into the flower; and butterflies, when doing so, could not fail to thrust their proboscis between the left and right anthers (as explained by the dotted line in Figs. 53 and 56), and to dust it with pollen-grains, which would partly be deposited on the stigma of the young flower next visited; for in young flowers (as shown in Figs. 51 and 53) the style overtops the tip of the beaked prolongation, and the stigma is placed before the minute opening, just in the way of any entering proboscis, whereas in older flowers the stigma is retracted behind the opening by an incurving of the style (as shown in Fig. 56). HERMANN MÜLLER

* H. Müller, "Befruchtung der Blumen durch Insecten," p. 294, *et seq.*

THE TRANSIT OF VENUS

THE long-anticipated Transit of Venus took place yesterday morning; and already has the first instalment of news from distant observers arrived. The Astronomer Royal has been good enough to inform us that Col. Tennant's observations at Roorkee, India, have been quite successful; 100 photographs have been taken. He also telegraphs, at the moment of going to press, the gratifying intelligence that the micrometric observations near Cairo and Suez, and the photographic observations at Thebes have entirely succeeded.

At the last meeting of the Astronomical Society the Astronomer Royal gave an account of the final arrangements of the English parties, which do not vary much from those we stated some time ago. Messrs. Green have arranged for one of their outgoing ships to pass near Kerguelen's Land, with a view of picking up intelligence and telegraphing it from Melbourne.

The southern stations occupied by the American, French, and German parties leave no doubt that the Halleyan method will be extensively employed.

The final arrangements of the French parties have been telegraphed to yesterday's *Times* as follows:—

"France has six stations—three in the Northern Hemisphere, at Pekin, Nagasaki, and Saigon; and three in the Southern Hemisphere, at Noumea, Campbell Island, and St. Paul's Island. Three of these, Nagasaki, Cochin China, and Noumea, present comparatively no difficulties as regards the voyage and installation. The Nagasaki Commission is headed by M. Janssen, member of the Institute and the Board of Longitude, who has taken part in several scientific voyages resulting in important discoveries. He is assisted by M. Tisserand, superintendent of the Toulouse Observatory, and M. Picard, a naval lieutenant, who will employ the photographic apparatus of MM. Fizeau and Cornu, while a professional photographer will use an apparatus invented by M. Janssen. In Cochin China there will be only one observer, M. Héraud, a hydrographic engineer. It was at first decided, as a measure of economy, to dispense with the observations in Cochin China, but it was ultimately resolved to profit by M. Héraud's presence in the colony. He will probably be stationed in Tonquin, of which he is preparing a map. M. André, of the Observatory, and M. Angot, of the College of France, have proceeded to Noumea with an equatorial and photographic lens. The observers at Pekin, St. Paul, and Campbell Islands have had to encounter greater difficulties. It is not very easy to reach Pekin with cumbrous luggage. The Commission has had to reach Tien-tsin by Suez and Shanghai, and thence proceed in junks by the canals. It is headed by M. Fifuriais, a naval lieutenant celebrated for his astronomical labours, and comprises two other naval officers, MM. Blarez and Lapied. Their return may be toilsome, as the winter will obstruct the transport of their instruments. At St. Paul and Campbell Islands the observers have had to found a temporary colony in uninhabited islands, without any resources. St. Paul, situated nearly in the centre of the line from the Cape to Australia, is the crater of a volcano which is becoming extinct. There are steep cliffs on all sides, but towards the west the cone sinks, and the interior of the crater forms a creek where vessels can penetrate. No pure water is to be found. The encampment has been established as near as possible to the sea, the salt water having to be distilled for drinking purposes. The St. Paul Commission is composed of M. Mouchez, captain and member of the Board of Longitude, the author of works on the coast of Brazil and Algeria; M. Turquet, naval lieutenant, long accustomed to astronomical observations, as his coadjutor; M. Cazin, an eminent Professor at the Lyceum of the Rue du Havre, who is entrusted with the photography; and a navy surgeon, M. Rochefort, who will devote himself to the natural history of the island. The Commission is accompanied by twelve naval officers and sailors. Campbell Island, the most distant station, is about 200 leagues south of New Zealand. It is likewise uninhabited, its climate seems disagreeable, and, unfortunately, the sky, as at St. Paul, is rarely free from clouds. It possesses, however, good water and a good port. The observers are MM. Bouquet and Hatt, both eminent hydrographic engineers; M. Courrejolles, naval lieutenant; and M. Filbol, the delegate of the Museum and the surgeon of the expedition. There are also twelve sailors. Everything necessary for the subsistence of sixteen men during three months has had to be transported to these two last stations, three months being necessary to determine the exact latitude and longitude of the observatories."

ON THE NORTHERN RANGE OF THE FALLOW DEER IN EUROPE

IN the interesting essay by Dr. Jeitteles, translated by Dr. Sclater, in NATURE, vol. xi. p. 71, many cases of the reputed discovery of the remains of the Fallow Deer are collected together to prove that the animal is indigenous in Northern Europe, and not imported from the south, as heretofore has been supposed by many able naturalists, such as Blasius, Steenstrup, Rütimeyer, the late Prof. Ed. Lartet, and others. These cases are accepted by Dr. Sclater without criticism, and are deemed by him to place the importation theory, as it may be termed, in the category of "ancient fables." The question, however, seems to me, after many years' study of the fossil and recent Cervidæ of this country and of France, a very difficult one, not to be decided off-hand, and certainly not without a strict

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